Appendix C: Civil Engineering

Mississippi River, Dubuque County Iowa
CAP Section 14 Emergency Streambank Protection

Dubuque Forced Sewer Main

Feasibility Phase

Doc Version: Final Feasibility Report
July 2021

The main goal of this Project is to stabilize the right descending river bank of the Mississippi River on the southern edge of the city of Dubuque in Dubuque County, Iowa, and to evaluate the potential effects of such action.

Riprap Revetment: Riprap revetment is a blanket of riprap placed on an eroding bank to resist erosive flows and protect the bank from further erosion. Revetment can be used on most any bank, whether it is straight or meandering in geometry. The riprap should be placed at a 1.5 to 3:1 H:V slope and armors the bankline from the toe of the bank up to 1 to 5 feet above normal pool height. Bank grading may be required to achieve the appropriate slope. The thickness of the placement is generally 18 to 36 inches, but the slope and thickness depend on the type of riprap, existing bank material, use of filter fabric or bedding stone, water velocity, and if the stone will experience freeze/thaw or ice action.

This Project feature was designed to be 24 inches thick Class C and sloped at 2:1 H:V, to be used along the right descending bank of the Mississippi River. The revetment does not include a weighted toe. The conceptual limits of riprap placement are shown in Figure C-1. The stone bedding thickness will be a minimum of 12 inches above the 42-inch" forced sewer main. A 6-inch-thick section of bedding stone will be used everywhere else in the project. See Figure C-2 for typical section.

Approximate quantities are as follows:

- 3,000± linear feet of riprap
- 22,400± tons of riprap
- 6,380± tons of bedding stone

Figure C-1. Locations of Proposed Riprap Revetment

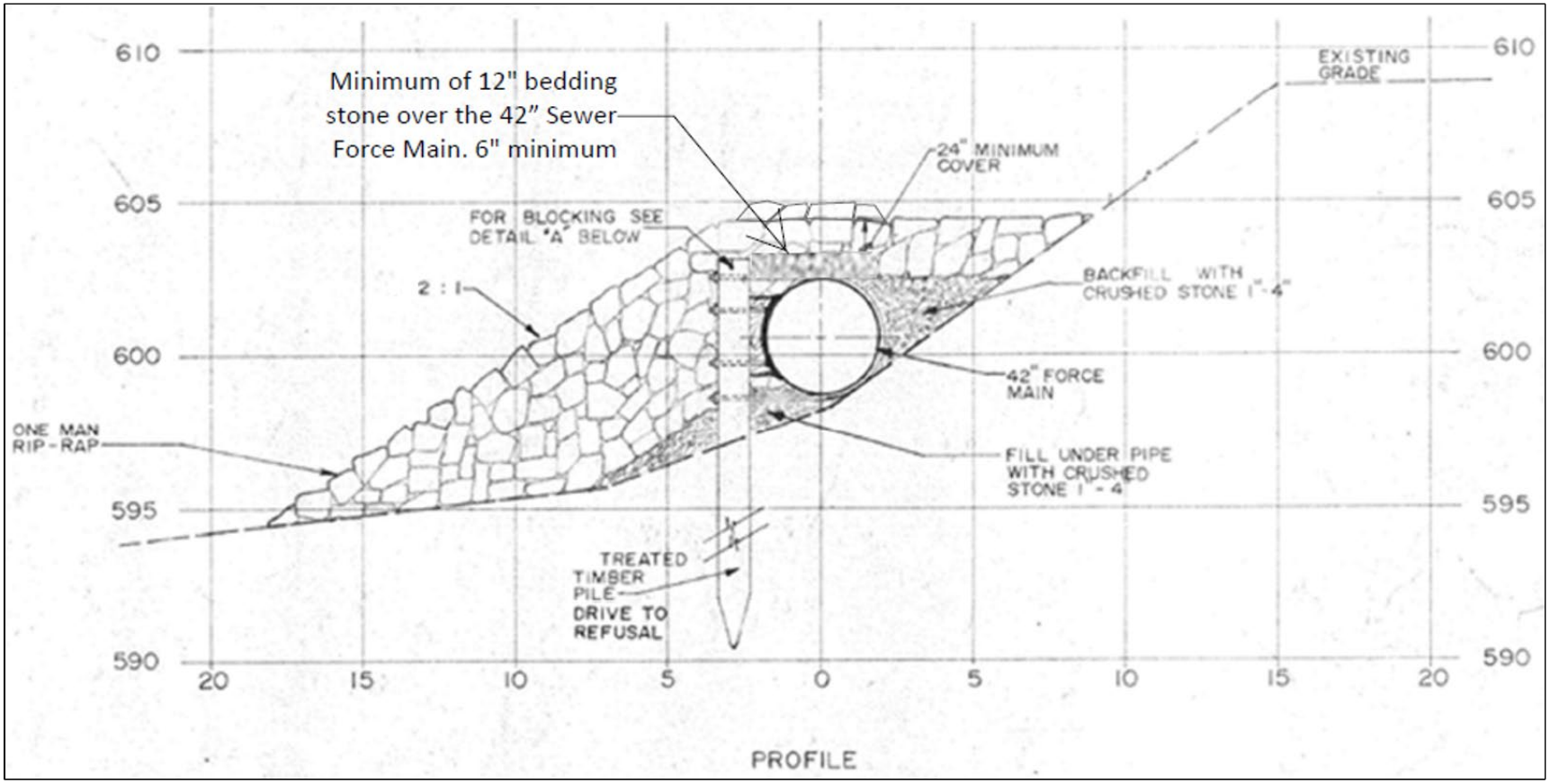

Figure C-2. Typical Section

Sheet Piles: Sheet piles are metal sheets pressed or molded so they interlock with other such sheets. They are driven into the earth as piles and can be used to retain water, soil or other materials. Depending on length, they are generally driven into the earth with a pile driving crane. They can be placed along a variety of geometries, including curved paths such as a river bend. Sheet piles work both by holding back soil that is eroding into the river and by serving as armor against the river's erosive forces.

Sheet piles were not designed for the Project, as historical costs indicated they would be too expensive. Additionally, the following points rule out this alternative as being viable.

- Accelerated degradation of the wall due to barge impacts will affect long-term durability.
- The flat surface of the sheet pile wall might actually invite more barge traffic to the area resulting in an increase in impacts. This is the opposite of what the Corps of Engineers, Rock Island District (District) is trying to accomplish for deterring barge traffic near the bank line to protect the existing sewer main.
- Driving the sheet piles through existing riprap/boulders/cobble will likely prevent the District from reaching required embedment depths on all of the piles and lead to damaged/misaligned piling.

Articulated Concrete Block Matting (ACB): An Articulated Concrete Block Matting (ACB or ACM) matting revetment is a system is of interconnected concrete block units installed to provide an erosion resistant revetment. It is static protection and applicable in high risk applications where no additional bank or grade movement is allowable. The system consists of concrete blocks, a filter typically made of a geotextile, and cables in some products. The individual units are connected by geometric interlock, cables, ropes, geotextiles, geogrids, or a combination thereof and, typically, overlay a geotextile for subsoil retention. The filter layer may consist of a geotextile, properly graded granular filter, or both. Proper design of the filter layer is critical to the successful performance of the ACB revetment system. The individual blocks of the system are able to conform to changes in the subgrade, while remaining connected due to the geometric interlock or other system components such as cables.

- ACM needs a relatively flat, uniform slope to be placed properly. This will be difficult to accomplish in the wet at our project site. The necessary placement environment is more critical than with riprap.
- The bedding beneath the ACM would require multiple layers including two layers of geotextile fabric with one layer of bedding stone in between. This is more complex and would require more materials than the single layer of bedding stone that would be needed for the riprap alternative. Also, placing geotextile fabric in the wet would be extremely difficult.
- The wires/cable that hold the blocks of the mat together are not intended to withstand impacts; they are simply used to hold the blocks together during placement. Barge/debris strikes would very likely lead to breaking of these cables and result in the loss of blocks, potentially having the same accelerated degradation concerns the District

had with the sheetpile alternative.

- In addition to key-ins at the upstream and downstream ends (similar to riprap), ACM needs to be anchored in at the top by excavating the landside behind the crest, placing the ACM, draping it up and over the crest then down the riverside slope, and backfill the excavated landside to anchor it in. This would require significantly more earthwork than the riprap option and may run into real estate issues with the train tracks. See Figure C-3.

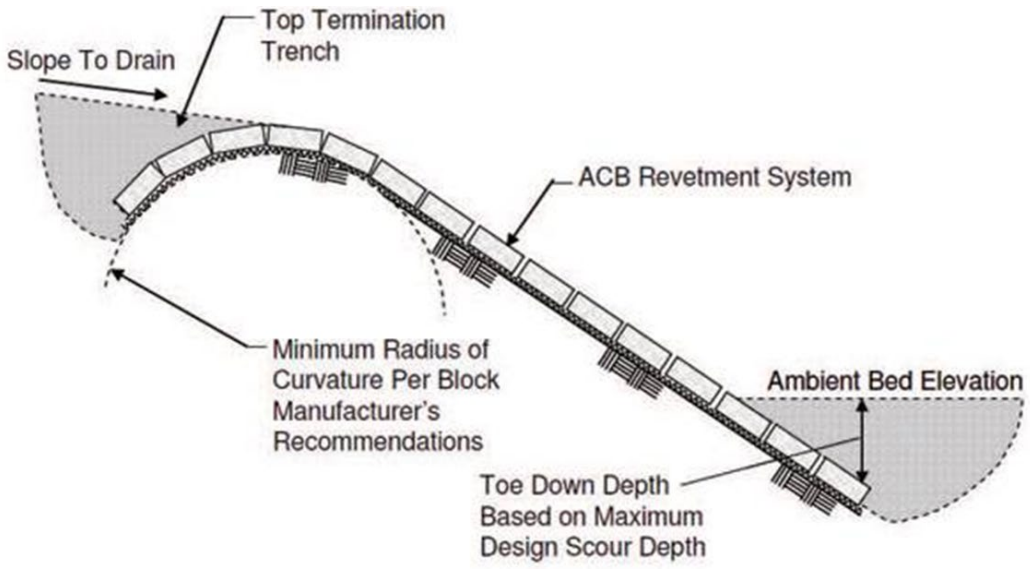

Figure C-3. ACM Diagram

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